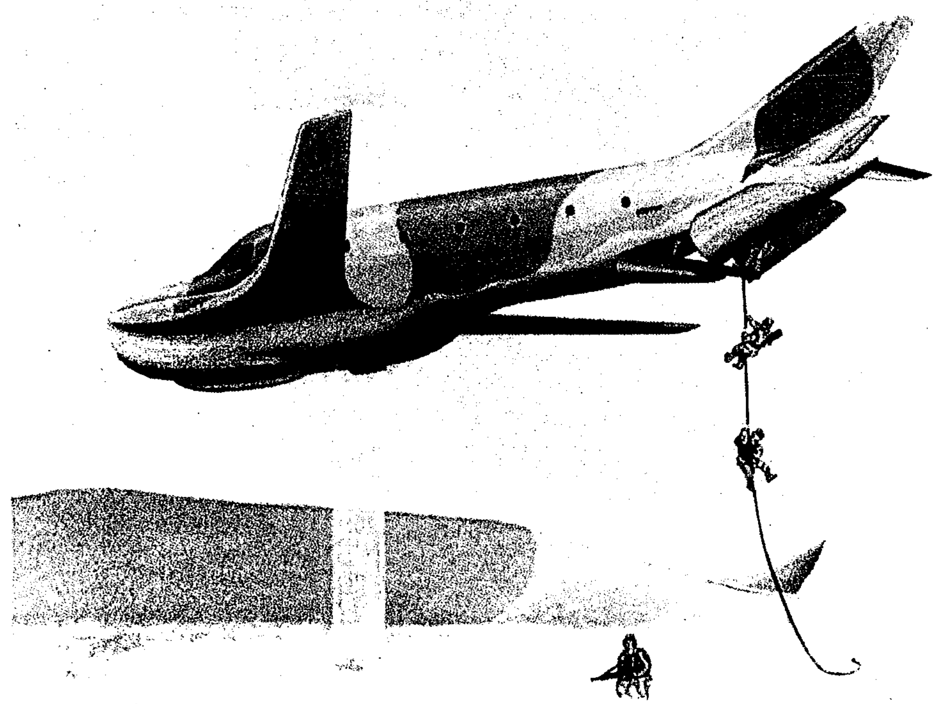
duPont Aerospace DP-2 Concept



TWIN-ENGINE HIGH-SPEED TRANSPORT CAPABLE OF HOVER AND VTOL

From: John_Kinzer@onr.navy.mil
To: Administration@duPontAero.com
Cc: Jan.Lepicovsky@grc.nasa.gov, whall@mail.arc.nasa.gov, rkl4@email.psu.edu, james.a.burkhart@grc.nasa.gov, MJTremper@aol.com, joe.krejmas@dupontaero.com
Subject: General Concerns over DP-2 Test Operations
Date: Fri, 23 Feb 2007 9:30 AM

Tony,

Mike has raised this concern a couple of times, but I want to emphasize it, due to its importance. Mike is taking the position that any deviation from govt approved procedures and TWD's will result in DCMA withdrawing it's approval for operations, and from any further contract support. From my position this will essentially terminate the contract, since there is little hope for, nor would I propose to ask for permission to continue without this oversight.

Examples of procedural violations that have occurred are:

Removal of nose tether without TWD approval
Conduct of hover tests in violation of agreed entry criteria for throttle free play / hysteresis
Pilot in cockpit during engine runups above idle
Attempting to install fences on the aircraft without an approved TWD
Placing the aircraft nose wheel on a block during IGE testing without an approved TWD

I'm sure Mike could provide other examples, which I'm sure he would be glad to do if there is any question as to what rises to the level of a procedural violation, as opposed to changes which are within the discretion of the company. My strong recommendation is that if there is any doubt as to whether or not a procedure or operation is approved. check with Mike and me.

We all want to move ahead safely.

John F. Kinzer
Program Officer, ONR 352
703-696-7917(W) / 703-217-3994 (C)

DEFENSE CONTRACT MANAGEMENT AGENCY
DEFENSE CONTRACT MANAGEMENT AGENCY WEST
18901 SO. WILMINGTON AVENUE
CARSON, CALIFORNIA 90746-2856

IN REPLY
REFER TO DCMADW-AO

12 Jan 2003

SUBJECT: 2003 Risk Assessment Management Program (RAMP)

To: Ms Denise Farnsworth

1. DCMDW AO conducted the 2002 RAMP on 27-28 Jan 2003. The results are attached to this letter. As Government Flight Representative, the Directive One Chapter 8.1 Para 4.6.2.2.2 requires me to forward these results to you within 10 working days of the completion of the assessment. DLAI 8210.1 requires you to review this assessment and forward it to the contractor. We have identified numerous areas of non-compliance. We expect considerable contractor effort to rectify the observations contained in this assessment. A response from the contractor is required within 30 days of receiving the report

2. The finding in this assessment is contract non-compliance, IAW DLAI 8210.1, and must be corrected. The observations and recommendations in this assessment are not to be considered directive in nature and should not be considered as constructive changes to the contract. If there are any questions, I can be reached at (714) 654-6176.

Michael J. Tremper, Maj., USAFR
Government Flight Representative

Cc:
Dr Thomas Taylor
LCDR Susan Randall
Mr. Collin Holman
Lt Col Randy Anderson

DEFENSE CONTRACT MANAGEMENT AGENCY
DEFENSE CONTRACT MANAGEMENT AGENCY WEST
18901 SO. WILMINGTON AVENUE
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IN REPLY
REFER TO DCMDW-AO

29 Jan 2003

SUBJECT: duPONT Aerospace 2003 Risk Assessment Management Program (RAMP)

TO: Ms. Denise Farnsworth

1. The duPONT Aerospace Aviation Program Team (APT) conducted the 2003 RAMP on 27-28 Jan 2003. The inspection focused on all aspects of duPont Aerospace ground and flight operations and it's compliance with the Defense Logistics Agency Manual (DLAM) 8210.1. The DLAM establishes requirements for all ground and flight operations involving work performed on aircraft where the Government has assumed some of the risk of loss for aircraft as well as procedures to be followed by the Government Flight Representative GFR.

2. The findings of the inspection revealed that the Contractor was noncompliant in virtually all aspects of their operation. The Contractor's approved procedures and the overall requirements of the DLAM are not being implemented to any acceptable level and reflect a fundamental disregard for compliance with the requirements. In addition, the attitude of key personnel in regard to the execution of their responsibilities and duties, i.e. checklist adherence, further reflect an unwillingness to act in accordance with established procedures.

3. The procedures outlined in the DLAM are essential in establishing processes which are used by the APT to assess and mitigate risk. These requirements are essentially non-existent in the Contractor's operation and therefore do not permit the APT to adequately evaluate the level of risk for duPont Aerospace aircraft operations. Until these procedures are established and incorporated into the Contractor's operation, an unacceptable level of risk exists. Without the proper safeguards in place, overall safety of personnel and property cannot be assured.

4. Due to the reasons outlined above, effective immediately, I am withdrawing GFR approval of the duPONT Aerospace Contractor's Ground and Flight Procedures and approval of aircraft test operations.

5. We expect considerable contractor effort to rectify this situation and anticipate future approval of the Contractor's Ground and Flight procedures. Once the GFR determines that duPONT Aerospace is again in compliance with the DLAM requirements, the Contractor's Ground and Flight Procedures will be approved and continued aircraft testing will be authorized. I will submit the RAMP Team Report within ten working days in accordance with DCMD 1, sec. 4.6.2.2.2.

Michael J. Tremper, Maj, USAFR
Government Flight Representative

Cc:
Dr. Thomas Taylor
LCDR Susan Randall
Mr. Collin Holman
Lt Col Randy Anderson

duPONT Aerospace Company RAMP
1725 N. Marshall Ave
El Cajon, Ca 92020

I. EXECUTIVE SUMMARY

A. INTRODUCTION/TEAM MEMBERS

The Annual Risk Assessment Management Program (RAMP) of duPONT Aerospace was accomplished 27-28 Jan 2003. The overall assessment value rating calculated was 7.9. The contractor's operations reside in the high risk area. The following RAMP team members conducted the assessment.

Maj. Michael Tremper, GFR, DCMDW-AO
MSgt Roderick Ignacio, AMM, DCMDW-AO
Ms Cyndi Gibson, CSM, DCMA Ontario
MSgt Craig Dubose, AMM, DCMA Mojave

B. PURPOSE

The purpose of the RAMP is to assess the level of risk the Government incurs through its aircraft contract with duPONT Aerospace. The RAMP process provides an open forum for duPONT Aerospace and the Aviation Program Team (APT) to jointly determine where the Government's risks lie and what steps can be taken to properly manage those risks. This RAMP fulfills the requirement of the joint regulation DLAI 8210.1 and Directive One to conduct an annual review of contractor operations covered by the Flight Risk Clause (DFARS 252.228-7002), ref. contract mod P0004, 02 Feb 2000. In conjunction with the RAMP, the team examined duPONT Aerospace Contractor's Procedures, contractual requirements, and ground crew qualifications.

The analysis contained in this report provides a tool to manage and lower risk. The goal is to improve the safety and security for all personnel involved, and to better protect and conserve government resources.

This report includes the teams' observations and findings that require actions to meet contractual requirements. It also includes the RAMP Spreadsheet that calculates the overall risk rating for this year's assessment. The information herein is to be considered sensitive and is not to be distributed outside DCMDW or DCMA channels.

C. DISCUSSION

1. Safety

a. **Safety Program**: Non-compliant

The following represents specific areas where the contractor is in conflict with the contract requirements and their Contractor's Ground Procedures, which were in place based on the Government Flight Representatives approval, dated April 2001. The contractor's overall safety program, although well documented, is essentially nonexistent and evidence could not be provided to demonstrate that the contractor minimally attempted to meet even their self imposed safety requirements or procedures. Moreover, the documented procedures indicate evidence of a more systemic problem with the contractor's overall corporate mindset in respect to meeting the necessary safety requirements to protect personnel and government programs and assets. Each individual deficiency requires a written corrective action as to cause and how the contractor will ensure the deficiency will not recur.

1. Mishap Prevention Program – The overall program is deficient although portions of the program are documented, it was clear that this documentation was only accomplished to meet the necessity to have a documented program rather then to apply the program to the contractors daily operations. The contractor must review to requirements in DLAI 8210.1 to ensure they have an active and demonstrable mishap prevention program.

2. The contractor lacks an active Consolidated Safety Council (CSC) to promote a program of mishap prevention in flight, ground and industrial activities. Although the contractor does call a meeting after each test engine run to discuss the safety aspects, this more resembles the process of a research and development discussion for that specific test. Consolidated Safety Council is typically a planned event, as indicated by the contractor's own documented procedures. Safety procedures 1003., paragraph 2 (sic 3) a. ii. Which states, in part that the meetings are scheduled, planned and not less than quarterly.

3. Consolidated Safety Council Minutes – The contractor was unsuccessfully in producing a minimum of four CSC meeting minutes for the past 12 months. Based on the absence of documentation, the contractor's safety program is deficient.

(Ref: DLAI 8210.1, E.3.a. (2) and the contractor's approved procedures, dtd 4/01, 1003., 2 (sic 3) a. ii.)

4. Consolidate Safety Council – Members of the CSC were listed as a potential 12 members with 3 identified as government personnel. The contractor essentially extracted the list from DLAI 8210.1 without regard to their capability to fill all 9 potential representatives. Secondly, no specific names were associated with the appointments and in many cases, based on the size of the company; personnel wore more than one "hat". The contractor needs to meet the requirement while tailoring it to their specific company. Further, employee name identification is necessary to ensure the proper personnel are actively participating in the meetings. REF: Approved procedures, dtd 4/01, Safety 1003. 2 (sic 3) a. i.

5. The contractor is required to publish the safety responsibilities of the Aviation Safety Officer. There was no documentation to support this has been accomplished. REF DLAI 8210.1, E.3.a. (1).

6. The contractor indicated that a formal written safety program was established in greater detail in CP 3750.6. (REF: approved procedures, dtd 4/01, Safety 1003. 2 (sic 3.)) This was incorrectly referenced. In an attempt to locate this document, the contractor realized it should read 3750.0, paragraph 1001. Further, it should be noted that this formal written safety program is a single page not addressing the minimum requirements of the State of California for a documented safety & health program. At a minimum the state requires injury and illness Prevention Programs for employers to include the following elements to be established, maintained and in writing: responsibility, compliance, communication, hazard assessment, accident/exposure investigation, hazard correction, training and instruction, and records documentation. Further guidance on the details of each area can be obtained from the local Cal OSHA office or their website.

7. Safety Publications – The contractor did not have readily accessible safety publications. (REF: DLAI 8210.1, E.3.(4).) The contractor, referenced in Company Procedures 3750.0, 1004.a. that personnel should use the Naval Safety Center's web page as well as other links not specifically referenced. There was no process to address Internet unavailability or a means to track if personnel were utilizing any safety publications.

8. Safety surveys – in accordance with the DLAI and the contractor's own procedures, the Aviation Safety Officer will conducted safety surveys at least quarterly. There was no evidence of this action being regularly accomplished. Further, the requirement also states the findings, recommendations and follow-up

will be recorded and maintained for review. There no documented records of surveys, corrective action or follow-up. (REF: Contractor Approved Procedures, dtd 4/01, 1003, 2 (sic3) b.)

9. Fuel Sample Program 6003 – Based on the approved contractor procedures, fuel sample intervals will be daily during flight and ground procedures. DuPont could not provide evidence that this process was being adhered to.

10. Fuel Sample Program 6003 – Based on the approved contractor procedures, all fuel samples are to recorded, whether contaminated or not.

11. Fuel Sample Program 6003 – Based on the approved contractor procedures, the Maintenance Supervisor will designate a Power Plant representative to be the fuel surveillance program manager. No records could be found to support this requirement being accomplished.

12. Fuel sample Program 6003 – Based on the approved contractor procedures, duPont will obtain fuel samples from the fuel truck or fuel bowser prior to or immediately after refueling. No supporting documentation was provided.

13. Oil Analysis Program 6004 – Based on the approved contractor procedures, duPont Maintenance Supervisor will designate a Power Plant representative to be the oil analysis program manager. No records supporting this designation were provided by duPont.

14. Oil Analysis Program 6004 – Based on the approved contractor procedures, oil sample records are to maintained. DuPont did not produce records for review to support this process of their program.

15. Tire and Wheel Safety 6006 – Based on the approved contractor procedures, the Maintenance Supervisor will designate in writing a certified tire/wheel individual as the Tire and Wheel Safety Program Manager. The contractor was unable to provide a copy of this appointment.

16. Oil Consumption Program 6007 – Based on the approved contractor procedures, the Maintenance Supervisor will designate an Oil Consumption representative to be the oil consumption program manager. The contractor indicated this has not been accomplished.

17. Maintenance Program 6008 – Based on the approved contractor procedures, the Maintenance Supervisor will designate a Maintenance Work Center Supervisor. The contractor could not provide records to support this designation.

18. Tool Control Program 6010 – Based on the approved contractor procedures, the Maintenance Supervisor will designate a Tool Control work center supervisor to be the tool control program manager. The contractor could not produce evidence of this appointment.

19. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, duPont will closely manage, throughout its life cycle, from acquisition to use and eventual disposal hazardous material. The contractor does not have a process in place to perform this program element. Evidence indicated a tremendous lack of hazardous material controls.

20. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, the Maintenance Supervisor will designate a Hazardous Material control program manager. There was no evidence that this has been accomplished.

21. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, duPont personnel are to gain adequate familiarity with local environmental office, hazardous waste laws, rules, regulations and procedures pertaining to duPont's maintenance Department. The contractor did not have the tools available to support their capability to accomplish this requirement. No access to regulations, environmental laws etc. were demonstrated during this review.

22. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, the work center supervisor will ensure compliance with all applicable federal, state and local regulations for their HMC&M Program. The contractor did not have a work center supervisor identified. The individual who indicated responsibility did not have training in respect to the regulatory laws and regulations in which duPont must conform to. Further, the handling of contaminated rags, hazardous materials and lack of immediately accessible eye wash stations indicated either a disregard for the laws and regulations or lack of knowledge of them. In either case, the contractor did not demonstrate an ability to meet this requirement.

23. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, the work center supervisor will conduct meetings with all work center supervisors for implementation, procedure review and

discussions of new regulations and requirements. The contractor was unable to provide evidence of this action being accomplished.

24. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, the work center supervisor will ensure storage facilities and hazardous waste collection points comply with established requirements. There was evidence that this was not being managed based on a 55 gallon drum of what the contractor indicated to be JetA fuel, being stored near the test area. The drum was not labeled nor grounded/bonded. Further, flammable material was stored side by side of a battery inside one of the hangars and numerous hazardous materials were stored on a wooden shelf with no controls in place.

25. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, the work center supervisor will ensure all flammables are stored in an approved flammable storage locker. This procedure was not met in several hangars where flammables were stored on wooden shelves or workbenches.

26. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, the work center supervisor will maintain and up-to-date library of all hazardous material used by each work center in the Maintenance Department. One binder was available for review with MSDS. It was not broken down to specify the hazardous material used by each work center. Interpretation of this procedure appears to require duPont management to have the hazardous material utilized broken down by work center. Satellite right-to-know binders, located in the specific work areas would provide contractor personnel readily accessible information as to the hazardous Material in their work center.

27. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, duPont will maintain a log to identify material issued, used, retained for reuse and disposed. The contractor was unable to produce and inventory list or other means of control of hazardous materials.

28. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, the contractor will ensure effective shelf life processes are in effect for the work center. The contractor maintained no inventory or means of material tracking and therefore could not produce evidence of ensuring shelf life of hazardous material used.

29. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, duPont will ensure an MSDS for each hazardous

material used is available in the work center. A random sampling was performed and the contractor could not locate the items within their MSDS binder. This indicates that the binder is not user friendly and in the event an individual required accessibility to a particular chemical for hazard identification it was unclear if they could obtain the necessary information in a timely manner.

30. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, duPont will ensure personnel directly involved in the handling and use of the hazardous materials receives job specific training. The contractor could not produce training records to reflect this action being accomplished.

31. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, the contractor will ensure hazardous material containers are properly labeled, segregated and free of corrosion and leakage. There were several day use containers, which were not label as to its content as well as the 55-gallon drum that the contractor indicated was JetA fuel.

32. Hazardous Material Control and Management Program 6012 – Based on the approved contractor procedures, the work center supervisor will ensure weekly inspections of the work center hazardous material and hazardous waste sites are accomplished and maintain a record of all inspections. There were no records to demonstrate this action being accomplished.

33. Electrostatic Discharge Program 6013 – Based on the approved contractor procedures, employees are to wear wrist straps, which shall be individually grounded through a 250K to 2M ohm resistor. The contractor had no means to test the wrist strap to ensure they have function capability. There no records to support that any of the conductive floor mat grounds were tested either.

34. Refueling and Defueling Procedures 6014 – Based on the approved contractor procedures, only approved personnel shall supervise fueling and defueling operations. There was no record on file that indicated which employees are considered approved. Therefore, there is no means to validate the operation.

35. Refueling and Defueling Procedures 6014 – Based on the approved contractor procedures, possible source of ignition shall be prohibited within a 50-foot radius of fuel/defuel and fuel system repair operations. The procedure also stated that "NO SMOKING- REFUELING AND DEFUELING" signs are to be displayed around a 50-foot diameter area around the aircraft being refueled or defueled. There was no signage or markings indicating the 50-foot radius. The contractor indicated they

did not bring out a temporary sign either to mark off the area during these procedures.

36. Refueling and Defueling Procedures 6014 – Based on the approved contractor procedures, duPont will employ the services of a professional fuel purveyor and further, duPont will ensure through direct inspection that the fuel truck and equipment is adequately maintained. The contractor indicated that they do not perform this task since they use a "professional fuel purveyor".

37. Refueling and Defueling Procedures 6014 – Based on the approved contractor procedures, smoking and open flames are not allowed within 50-feet of aircraft. There was no indication of the 50-foot area, if the facility was a no smoking facility or if not, where the designated smoking area would be in respect to the 50-foot requirement.

38. Aircraft Jacking 6022 – Based on the approved contractor procedures, the maintenance supervisor will designate in writing a jacking Safety Program Manager. No appointment letter was on file to support this tasking being accomplished.

2. Ground Operations

a. **Ground Operations Procedures** (GOP): Non-compliant

1. Adherence to Contractor's Procedures are not being enforced. Affected Procedures include

    i. Fuel Sampling procedure

    ii. Towing procedure

    iii. Refuel/De-fuel procedure

2. DLAI 8210.1 requirements are known but are not (in general) met by the Contractor

b. **FOD and Tool Control**: Non-compliant

1. The contractor does not enforce/adhere to approved procedures

i. Tools are not marked per Contractor procedures

ii. Tools are not shadowed per Contractor procedures

iii. Tools missing from tool board – no accountability. Missing tools included 10' crescent wrench, die grinder, combination wrenches, and safety glasses.

iv. Calibration data could not be confirmed on 3 torque wrenches – calibration sticker missing.

v. The Contractor does not adhered to the Lost Tool Procedure

c. **Training and Certification**: Non-Compliant

1. Contractor Procedures do not identify Certification requirements
2. Tasks that require initial and annual recurring certification are not identified nor documented
3. The Contractor does not maintain records with documentation of medical examination, as appropriate, of all ground personnel

d. **Engine Runs**: Non-compliant

1. The contractor does not enforce/adhere to approved procedures

   i. Engine run checklist changes were not approved.

   ii. Emergency engine fire checklist was not utilized during emergency knowledge evaluation.

   iii. Identified engine run individual was unfamiliar with engine fire checklist procedures.

2. Engine run personnel do not have documentation of certification

   i. Not all personnel identified as qualified to perform engine runs had current FAA medical record on file.

e. **Corrective Action Requests** – Non-Compliant. No procedure in place.

3. AIRCRAFT RESCUE and FIRE FIGHTING PROGRAM

a. Aircraft rescue and fire fighting response program is not included in the contractor's semiannual flight survey.

b. No record of testing fire fighting response or establishment of ARFF response time.

c. Contractor depends on outside agency for ARFF response with no appropriate MOUs/MOA or similar reference on file.

4. FACILITIES and PROPERTY PROTECTION

a. Instances of improperly stored chemicals and explosives. Items include jet fuel, cleaning solvents, petroleum products, and other flammable items.

D. CONCLUSIONS

This RAMP risk rating reflects a thorough assessment accomplished by the duPONT Aerospace APT. The inspection findings indicate that the contractor was non-compliant throughout all areas of its operation. While the approved Contractor's Ground Procedures sufficiently address many of the DLAI requirements, the required documentation and overall implementation of programs outlined in the procedures and the DLAI are virtually non-existent. Another major source of concern is the statements of key company personnel in regard to checklist adherence and following proper procedure, i.e. preference to "not call the fire department" for an aircraft fire. This appears to reflect a fundament disregard toward implementation and compliance with the requirements.

It is essential that DLAI 8210.1 requirements be fully complied with in order adequately assess and mitigate risk levels. We anticipate that after fully reviewing the findings of the RAMP inspection, duPONT Aerospace will provide an extensive effort within the company to address and remedy all areas in non-compliance.

DEPARTMENT OF THE NAVY
NAVAL AIR PROPULSION CENTER
P.O. BOX 7176
TRENTON, NEW JERSEY 08628-0176

NAPC-LR-86-13

AN ASSESSMENT OF THE DUPONT AEROSPACE COMPANY MODEL DP-2 AIRCRAFT

FINAL REPORT

11 APRIL 1986

Prepared by: J. L. PALCZA

LT. J. W. MCCLEAN

Typed by: Suzanne S. Mc Crossin

Approved by: CDR A. G. HUTCHINS, JR.
Director, PE

Naval air power · in defense of freedom

TAB A

NAPC-LR-86-13

AN ASSESSMENT OF THE DUPONT AEROSPACE COMPANY MODEL DP-2 AIRCRAFT

FINAL REPORT

References

(a) NAPC ltr Ser PE34/F952 of 4 Apr 85 to Mr. P. Bahnsen, Office of the Undersecretary of Defense for Research and Engineering (C^3I)

(b) NAVEODTECHCEN Work Request No. N0464A85WR10494 dated 19 Jun 85

(c) NAPC Work Request No. N6237686-WR-000-25 of 15 Nov 85

(d) DP-2 Three View Drawing, Attachment No. 1 to Contract No. N00174-85-M-5370 of 10 Oct 84

(e) DP-2M DuPont Jet Transport Model Specification (latest revision), Attachment No. 2 to Contract No. N00174-85-M-5370 of 30 Aug 85

(f) Report on Flight Dynamics of the DP-2, Attachment No. 3 to Contract No. N00174-85-M-5370 of Jul 85

(g) Model DP-2 Wind Tunnel Data Report, Attachment No. 4 to Contract No. N00174-85-M-5370 of Aug 85

(h) Description of Attitude Control and Height Control Methods, Attachment No. 5 to Contract No. N00174-85-M-5370 of Dec 85

(i) Model DP-2M Detailed Weight Statement, Attachment No. 6 to Contract No. N00174-85-M-5370 of Sep 85

(j) Propulsion System Installation Drawings, Attachment No. 7 to Contract No. N00174-85-M-5370 of Dec 85

(k) Model DP-2 Duct Areas and Mach Numbers, Attachment No. 8 to Contract No. N00174-85-M-5370 of Dec 85

(l) Photographs of Full Scale Aircraft Mockup Nozzle and Thrust Vectoring System, Attachment No. 9 to Contract No. N00174-85-M-5370 of Dec 85

(m) Results of a Seven Month Study to Evaluate and Improve the Wing of the DuPont Aerospace Model DP-2, D. Stecker, Stecker Associates of 1 Oct 84

(n) Briefing to the Naval Air Propulsion Center by A. DuPont of DuPont Aerospace Company, 20 Dec 84

(o) Bureau of Naval Weapons, "Aircraft Preliminary Design Methods Used in the Weapons Systems Analysis Division," Jun 62

(p) Royal Aeronautical Society, "Lift-Curve Slope and Aerodynamic Centre Position of Wings in Inviscid Subsonic Flow," Engineering Sciences Data Unit of Jan 71

(q) V/STOL-A Lift/Cruise Vectoring Systems Five Percent Scaled Model Thrust Vector Tests, McDonnell Aircraft Company Jul 77 (Proprietary Data)

(r) NADC Report-78256-60, "Computerized Method for an Estimate of Hot Gas Reingestion for a VTOL Aircraft at the Conceptual Design Stage," of 13 Aug 79

(s) TF34-GE-400A Customer Deck 74SC013, General Electric Engine Company, Aircraft Engine Group, Lynn, MA of 31 May 74

(t) "Fundamentals of Aircraft Design," by Nicolai, L., Domicone Printing Services, Fairborn, OH 1975

Enclosures

(1) Figures 1 through 16
(2) Tables I through XV

1. Introduction.

a. At the request of the Under Secretary of Defense for Research and Engineering (C^3I, Mr. Peter Bahnsen, references a-c), the Naval Air Propulsion Center was tasked with evaluating certain aspects of the DuPont Aerospace Company Model DP-2 aircraft design (references d-m). The Naval Air Development Center assisted in the evaluation. The objectives of the evaluation were to assess the feasibility of the thrust vectoring Vertical/Short Takeoff and Landing (V/STOL) concept embodied in the Model DP-2 and to assess the DuPont aerodynamic and mission performance quotes.

b. The DuPont Model DP-2, shown in Figure 1, enclosure (1), is a twin-engine, subsonic V/STOL aircraft design which is intended for utility and transport applications. The design employs a conventional wing-body-tail arrangement with an unusual engine installation. The engines are installed immediately under the forward fuselage so that the thrust, when vectored vertically, acts through (or nearly so) the aircraft center-of-gravity. The wing has an aspect ratio of 6.85, a quarter chord sweep of 42 degrees, and uses a modified Whitcomb supercritical airfoil. The empennage is conventional, and the landing gear is a conventional tricycle arrangement.

c. The Model DP-2 thrust vectoring system, shown in Figures 1-2, enclosure (1), use a set of cascade vanes to turn the engine exhaust through the desired angle. Two sets of orthogonal vanes, which are located in a "control box" at the end of the cascade vane assembly, provide moments for control in the powered lift flight regime (hover, STOL and transition to and from wing-borne flight). The longitudinal vanes are movable with respect to the "control box" and are used to provide rolling moments. The lateral vanes are fixed; the entire control box is rotated to change the relative position of these vanes. Symmetric movement of the two boxes produces a pitching moment while asymmetric movement produces a yawing moment. Altitude is controlled through engine power lever movement. Figures 1-3, enclosure (1), show, for the rolling moment case, the development of a control moment through the deflection of the control vanes.

d. The DP-2 has a design maximum takeoff gross weight of 32,000 pounds, a design maximum landing weight of 28,000 pounds, and an empty weight of 15,128 pounds. It is powered by two General Electric TF34 turbofan engines. Figure 4, enclosure (1) shows other characteristics of the Model DP-2. Figure 5, enclosure (1) shows fuselage layouts for cargo and for troop carrying missions. Figure 6, enclosure (1) shows DuPont estimates of DP-2 performance for the Special Operating Forces (SOF) mission.

e. The following discussions assess the DuPont Model DP-2 in the areas of aerodynamics, propulsion system (inlet and nozzle performance, installed thrust), stability and control, weights and mission performance. These assessments are based on information and data which were provided by the DuPont Aerospace Company; the information was both written (references d-m) and verbal (telephone discussions). Mission performance of the DP-2 is assessed only for the SOF mission.

2. <u>Conclusions</u>.

a. DuPont's drag predictions are in agreement with Navy analysis for the model DP-2 aircraft. The DP-2 should be able to achieve the quoted speed performance. At sea level, the aircraft's maximum speed will be limited by the TF34 engine's maximum speed of 466 knots (kt).

b. The cascade and vane control box thrust deflection system is excessively inefficient. The capture efficiency of the system is poor since it has no flow containing sidewalls. The turning efficiency of the vane system over the wide range of turning angles required to transition from VTOL to cruise flight will also be poor.

c. The substantial variation in nozzle exit area (2:1 or more) between the VTOL and cruise modes could cause significant thrust loss in one of these modes. It could also cause engine surge or stall during transition from VTOL to cruise.

d. Due to the close proximity of the engines to each other, the concept is essentially a single jet concept. There is no appreciable fountain effect to offset the inherent suckdown effect, hence greater installed thrust would be required for VTOL capability. The low mounted inlets are also highly susceptible to exhaust gas reingestion, which further degrades net thrust. Navy analysis indicates that the net thrust available for VTOL capability is less than the empty weight of the aircraft, so no VTOL capability actually exists.

e. In the cruise mode the exhaust system scrubbing drag will cause a thrust loss of 1 percent to 5 percent due to the large amount of nozzle wetted area.

f. Control moment magnitudes are inadequate for necessary control. Roll/translation cross coupling problems exist due to the exclusive use of vectored thrust for control. These cross coupling problems received poor pilot ratings in simulator tests of VSTOL designs whose control systems were similar to that of the DP-2. Coupling of height control with pitch, roll and yaw control by using vectored thrust will result in a high pilot workload in hover.

g. The center of gravity location is a fundamental problem. In the DuPont proposal the center of gravity (CG) is located forward of the vane control box. Consequently, a large nose down pitching moment would occur in attempting VTOL hover. If the CG were moved over the vane control box, this would place it aft of the aircraft's aerodynamic center, thus the aircraft would be longitudinally unstable in cruise. There is no apparent CG location which ensures both VTOL stability and cruise longitudinal stability.

h. In order to evaluate control power, the installed engine thrust was artificially increased by 50 percent in order to provide sufficient power for control. Based on Advisory Group for Aeronautical Research and Development (AGARD) 577 standards, the DP-2 control power was marginal in roll, and unacceptably low in pitch and yaw.

i. There are several differences in component weights between Navy estimates and the DuPont estimates. The Navy CG estimate is 8.5 inches further forward than DuPont's. The hover pitch angle estimate for the DP-2 is 20°-30° nose up, while the generally accepted limit is 10°.

j. With two TF34 engines the DP-2 has no VTOL capability.

k. The Navy estimates a mission <u>radius</u> of 547 nautical miles (nm) as compared to DuPont's claim of 1200 nm. In order to achieve a 1200 nm range, the cruise specific fuel consumption (SFC) would have to be 16 percent lower than the SFC for an uninstalled TF34.

l. The DP-2 has a poor radar cross section, particularly from the frontal hemisphere.

3. <u>Recommendations</u>. We recommend that the DuPont DP-2 concept be dropped as a solution to the SOF V/STOL mission.

4. <u>Discussions</u>.

a. <u>Detailed Evaluation</u>.

(1) <u>Model DP-2 Aerodynamics</u>

(a) DP-2 zero-lift and induced drag were estimated using the component buildup methodology of reference (o). Inputs to this methodology were DP-2 geometric characteristics. All computations were based on a Reynolds number of 22,655,000 (cruise at 250 kt at sea level). A total minimum drag coefficient of 0.01722, based on a wing area of 419.2 ft^2, was estimated as shown in Table I, enclosure (2). The only direct comparison that can be made with information available from DuPont is a comparison between minimum drag coefficients of the wing. DuPont's S13 wing (the latest design -- it appears as though there have been many iterations on the design of the wing) is advertised as having a 0.005622 zero-lift drag coefficient. This value is only 2 percent less than the Navy estimated value. Results from the DuPont Wind Tunnel Data Report (reference (g)) show a minimum drag coefficient of 0.01675. This is only 3 percent lower than the Navy estimated value.

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WASHINGTON OFFICE
9620 GLENCREST LANE
KENSINGTON, MARYLAND 20795

(301) 933-6360

13 October 1986

Mr. John K. Reingruber
Executive Manager
Naval Explosive Ordnance
Disposal Tech Center
Indian Head, Maryland 20640

Dear Mr. Reingruber,

As a result of the information you gave us last week, we have prepared and attached hereto some additional information regarding the design and performance of the Model DP-2 VSTOL transport.

We note that the Navy calculations for the drag and total weight of the Dp-2 are in agreement with ours, and that the Navy feels that the DP-2 should be able to achieve the speed performance that we quoted.

The concerns that have been expressed about the DP-2 center around the following factors:

A. Installed engine performance of the GE TF-34 engine in the DP-2 airplane.

B. VTOL Operations.

C. DP-2 Operating Radius for the SOF Mission.

D. DP-2 Stability and Control.

E. Radar Cross Section.

The information in the attached document is organized around these subjects.

This document also identifies the technical issues which cannot be fully resolved by analyses, wind tunnel tests, or computer simulations. These are the issues which can only be settled by full scale tests with two GE TF-34 engines.

If the attached information does not settle the different conclusions which have been reached, we would be pleased to discuss this with you further, or provide whatever additional information may be required to resolve the issues.

The concept of vectored thrust as embodied in the DP-2 can provide the military services with a very high performance VSTOL transport capable of performing the SOF mission and a wide variety of other missions. It has the added merit of being a relativly simple airplane, it can be put into production quickly with Sikorsky Aircraft fabricating the airplane parts, and it will not require a large government R&D program (duPont Aerospace has financed the R&D costs to date). Furthermore, the concept of vectored thrust has significant performance growth potential which can be readily achieved when new engines are available with improved thrust-to-weight ratios.

The potential of vectored thrust for VSTOL transport missions is so great, and the cost of proving that the concept will work is so modest, we feel that a full scale test of the system as outlined in the attached document would be a project with very low technical risk and very high cost-effectiveness.

Sincerely yours,

duPONT AEROSPACE COMPANY, INCORPORATED

Anthony A. du Pont

Anthony A. duPont
President

Attachments

cc: Mr. Peter Bahnsen,
OUSDRE

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
1400 WILSON BOULEVARD
ARLINGTON, VA 22209-2308

APR 19 1990

TECHNOLOGY ASSESSMENT DP-2 AIRCRAFT CONCEPT

ISSUE: The duPont Aircraft Company has proposed that a conceptual design for a civilian transport be modified to meet the requirements of the Special Operations Forces (SOF). DARPA has reviewed the requirements (Fig. 1), the duPont proposal (Fig.2), consulted with the most knowledgeable technical and operational specialists available, and prepared these findings.

FINDING #1

The DP-2 concept had its origin in a commercial transport application. In this environment the aircraft was envisioned to operate from prepared site commercial airports. The anticipated requirements for the SOF require a transport aircraft that operates to/from unprepared sites in order to insure mission flexibility.

The DP-2 design incorporates two 9200 lb thrust TF-34 engines which vector the thrust downward for vertical takeoff/landing. The temperature and velocity parameters of this jet exhaust erode unprepared surfaces, creating dust storms which impede visibility and endanger ground personnel as well as uproot unprepared surfaces which could be ingested and damage the engines. No technical data on this critical issue was provided by duPont Aerospace in the proposal to extend the DP-2 commercial design to a military application.

FINDING #2

Since the aircraft requires both engines to ascend/descend safely during vertical takeoff/landing operations, loss of an engine during this operation creates a control problem. If the ground erosion (Finding #1) causes loss of an engine, the DP-2 will be unstable.

A two engine Vertical Takeoff/Landing (VTOL) transport aircraft, without ejection seats, poses an unacceptable hazard upon loss a single engine.

FINDING #3

For some of the range/payload configurations envisioned by the SOF, the DP-2 would require the inflight shutdown of one of its two engines to conserve fuel. While this tactic is acceptable on multiengine military aircraft it is unadvisable on a two engine aircraft except in the most unique situations.

FINDING #4

The assertion has been made by duPont Aerospace that the radar signature of the DP-2 can be significantly reduced from similar transport aircraft for SOF missions. The concept is that a few aircraft of a transport fleet could incorporate modifications to reduce significantly the signature and thereby enhance survivability for special missions.

Expert opinion from government personnel familiar with low signature aircraft design/threat radar capabilities stated that the reduced signature variant of the DP-2 makes it only marginally more survivable than an unmodified version and remains inadequate to perform covert SOF missions.

OVERALL ASSESSMENT

The duPont Aerospace Corporation has asserted that the DP-2 conceptual design can be modified to meet the requirements of the Special Operations Forces.

It is DARPA'S assessment that the design cannot be adapted from its commercial aircraft application to the military requirement. The conceptual aircraft will not have unrestricted access to unprepared sites, will have serious control problems under one engine out conditions, and cannot be modified sufficiently to reduce its radar signature. The design compromises required to reduce its radar signature significantly for the SOF application would decrease its efficiency and desirability as a commercial transport aircraft.

Additionally, concern over the practicality of the basic DP-2 aircraft was expressed by the technical experts consulted by DARPA. The concept of using the single cascade vane structure for both lifting the aircraft and simultaneously making instantaneous roll, pitch, and translation corrections under dynamic (crosswind gust) conditions was considered ambitious. Bringing this propulsion concept to fruition will be an expensive undertaking for the basic aircraft. Even if these concerns over the DP-2 propulsion concept were to be resolved, the DP-2's inability to meet the SOF requirement for unrestricted landing sites precludes DoD from undertaking an investment in determining the viability of the DP-2 propulsion design.

The comments and concerns of the technical and operational experts who received a detailed briefing on the DP-2 concept are included as appendix 2.

DARPA

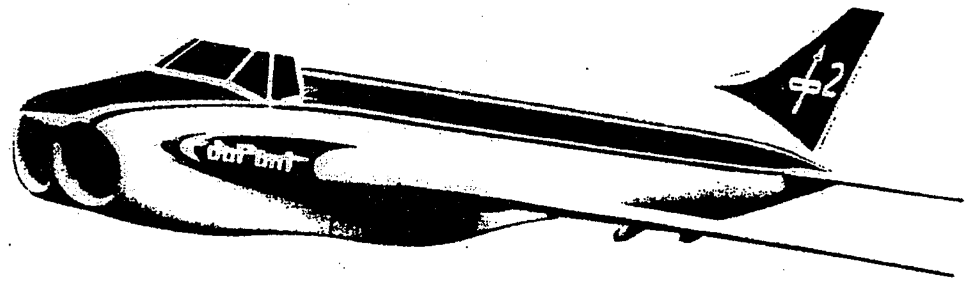
Strawman Capability Needs

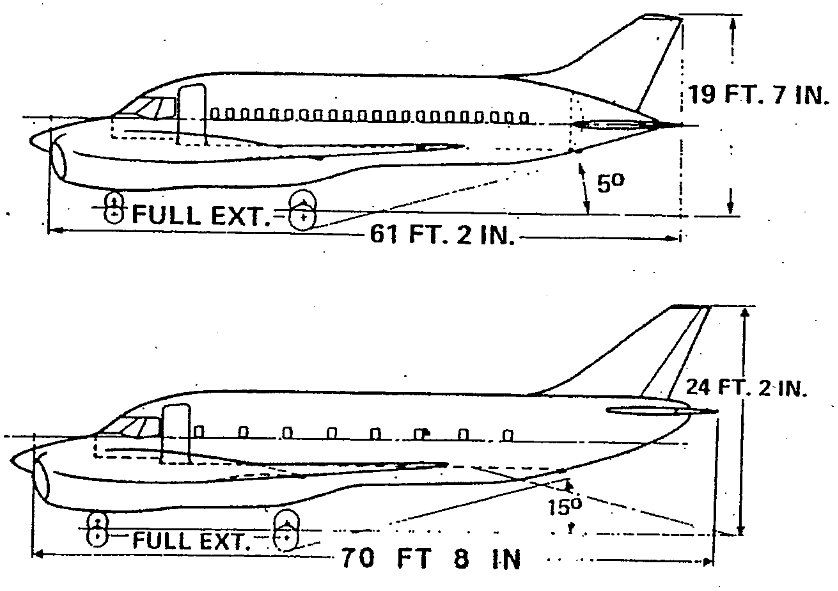
ASTO

• SOF MISSION AREAS	DROP / PICK-UP / RESUPPLY A-TEAM / SEAL PLATOON
• SELF DEPLOYMENT	2400 nm
• COMBAT RADIUS	750 - 1000 nm
• STOL	1500 ft OVER 50ft OBSTACLE
• VTOL	at MIDPOINT
• HOVER	5 min at MIDPOINT (4000 ft, 95 °F)
• SPEED	250 KTS to 450 KTS at LOW ALTITUDE
• PAYLOAD	4000 lbs (DESIGN) to 10,000 lbs OVERLOAD
• AVIONICS	NIGHT / ADVERSE WEATHER / LOW EMISSIONS / ECM
• SIGNATURE	LOW to MODERATE
• R&M	SYSTEM RELIABILITY 92%; FIX 85% in <4 hrs
• CLANDESTINE OPS	UP TO 75% OF PENETRATING SORTIES

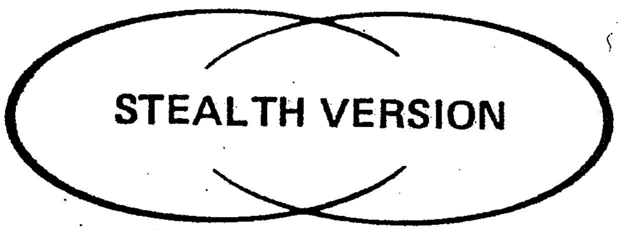
FIGURE 1

DP-2





- **AIRLINER**
  - ☐ 44 PASSENGERS
  - ☐ COAST-TO-COAST RANGE WITH 33 PASSENGERS
  - ☐ LOWER OPERATING COSTS
- **COMBAT TRANSPORT**
  - ☐ 10,000 POUND PAYLOAD
  - ☐ 1,000 NMI RADIUS
  - ☐ 350 KNOTS, SEA LEVEL
  - ☐ CAN OPERATE VTOL AT MID POINT



U.S. Patent No. 4,482,109

duPONT AEROSPACE COMPANY, INC.

FIGURE 2

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

WASHINGTON, DC 20301-3010

EXECUTIVE SUMMARY

MEMORANDUM FOR THE SECRETARY OF DEFENSE

THROUGH: DEPUTY SECRETARY OF DEFENSE
UNDER SECRETARY OF DEFENSE (ACQUISITION)

FROM: DIRECTOR, DEFENSE RESEARCH AND ENGINEERING

SUBJECT: DP-2 Vectored Thrust Aircraft

PURPOSE: INFORMATION - Respond to SECDEF request for report on DP-2

DISCUSSION: The DP-2 is a vertical/short take-off and landing (V/STOL) transport aircraft concept developed in the early 70's by the duPont Aerospace Company. The concept features a series of vanes - similar to venetian blinds - behind a conventionally mounted engine that can vector engine exhaust from purely horizontal (thrust) to purely vertical (lift). The operation of this concept would be similar to that of an AV-8B. Though originally conceived as a commercial transport capable of carrying 25-30 passengers, a militarized version of the DP-2 featuring stealth applications has most recently been suggested.

The DP-2 has been proposed several times to the Navy. Each time, the concept was rejected due to serious technical deficiencies. In 1986, the Navy published a report that presented a detailed analysis of the DP-2 (Tab A). Deficiencies identified included poor stability and control margin in hover, poor stealth characteristics, serious ground erosion problems and safety-of-flight issues. In FY88, $3M in unrequested funds were appropriated for DARPA to experimentally evaluate the DP-2. DARPA conducted a detailed technical review (Tab B) and chose not to invest in the DP-2 for many of the same reasons identified by the Navy. In FY91, unrequested funds were appropriated for DARPA to invest up to $15M in DP-2 development relative to its application to a SOF transport. Mr. Yockey had the results of DARPA's prior review assessed by the Defense Science Board Chairman Dr. John Foster who recommended against investment in the concept.

DARPA has recently worked with SOCOM to define an alternative joint program to investigate V/STOL applications for SOF missions (Tab C). This approach would satisfy immediate needs of SOCOM and offer a technically viable response to the FY91 language.

COORDINATIONS: General Counsel ________________
ASD (LA) ________________
DoD (C) ________________

Prepared By: C. Heber/ASTO/DARPA/62304/August 6,1991 CEH
Approved By: Victor H. Reis, Director, DARPA VHR

ADVANCED RESEARCH PROJECTS AGENCY
3701 NORTH FAIRFAX DRIVE
ARLINGTON, VA 22203-1714

EXECUTIVE SUMMARY

MEMORANDUM FOR THE DEPUTY SECRETARY OF DEFENSE

THROUGH: UNDER SECRETARY OF DEFENSE (ACQUISITION)

FROM: DIRECTOR, ADVANCED RESEARCH PROJECTS AGENCY AD MAR 31 1993

SUBJECT: DP-2 Vectored Thrust Aircraft

PURPOSE: INFORMATION - Respond to DEPSECDEF request for information on DP-2

DISCUSSION: The DP-2 is a vertical/short take-off and landing (V/STOL) transport aircraft concept developed in the early 70's by the duPont Aerospace Company. The concept features a series of vanes - similar to venetian blinds - behind a conventionally mounted engine that can vector engine exhaust from purely horizontal (thrust) to purely vertical (lift). The operation of this concept would be similar to that of an AV-8B. Though originally conceived as a commercial transport capable of carrying 25-30 passengers, a militarized version of the DP-2 featuring stealth applications has most recently been suggested.

The DP-2 has been proposed several times to DoD. Each time, the concept was rejected due to serious technical deficiencies. In 1986, the Navy published a report that presented a detailed analysis of the DP-2 (TAB A). Deficiencies identified included poor stability and control margin in hover, poor stealth characteristics, serious ground erosion problems and safety-of-flight issues. In FY 1988, $3M in unrequested funds were appropriated for ARPA to experimentally evaluate the DP-2. ARPA conducted a detailed technical review (TAB B) and chose not to invest in the DP-2 for many of the same reasons identified by the Navy. In FY 1991, unrequested funds were appropriated for ARPA to invest up to $15M in DP-2 development relative to its application to a SOF transport. Subsequently, the results of ARPA's prior review were assessed by the Defense Science Board Chairman Dr. John Foster who recommended against investment in the concept. Alternatives for investment of the funds were suggested to duPont and supporting congressional members but, in each of the previous appropriations, the funds expired before being expended. Again, in the FY 1993 appropriation, $15M was identified for DP-2 development. ARPA has evaluated duPont's latest proposal and has found it to contain the same technical deficiencies uncovered in previous evaluations.

At the present time, ARPA does not intend to execute this program due to serious technical flaws imbedded in the concept. The FY 1993 Congressional language is such that we are not explicitly required to execute the program.

Prepared By: C.E.Heber/ASTO/ARPA/62304/March 30, 1993
Approved By: R.D. Murphy, Director, ASTO/ARPA

ORIGINATING OFFICIAL FILE COPY

BACKGROUND PAPER ON THE DP-2 CONCEPT

The DP-2 is a vertical/short take-off and landing (V/STOL) transport aircraft concept developed in the early 70's by the duPont Aerospace Company. The concept features a series of vanes - similar to venetian blinds - behind a conventionally mounted engine that can vector engine exhaust from purely horizontal (thrust) to purely vertical (lift). The operation of this concept would be similar to that of an AV-8B. Though originally conceived as a commercial transport capable of carrying 25-30 passengers, a militarized version of the DP-2 featuring limited stealth applications has most recently been suggested.

DuPont has been marketing various versions of the DP-2 concept since the early 70's. Each time, the concept was rejected due to serious technical deficiencies. In 1986, the Navy published a report that presented a detailed analysis of the DP-2, identifying a number of serious technical deficiencies. Deficiencies identified included:

- inefficiency of the basic DP-2 thrust vectoring concept
- poor ground effect characteristics including large suckdown penalties and hot gas reingestion problems
- poor stability/controllability in hover
- complete lack of engine out safety considerations
- marginal VTOL capability
- high disc loading/hot exhaust gas temperature leading to serious ground erosion problems
- incompatibility of the DP-2 configuration with even modest reductions in low frequency radar cross-section.

In March 1990, ARPA conducted a detailed technical review and chose not to invest in the DP-2 for many of the same reasons identified by the Navy. In December 1990, Mr. Yockey had the results of ARPA's prior review assessed by the Defense Science Board Chairman Dr. John Foster who also recommended against investment in the concept.

Currently, there is no user in DoD supporting the DP-2 concept. Though heavily marketed as a transport for Special Operations Forces, the DP-2 has not received serious consideration. The DP-2 was evaluated previously by the Special Operations Command and disqualified from a 1988 Special Operations Force transport aircraft competition.

ARPA's position has been and continues to be that, given the multiplicity of technical shortcomings and given that no interested users in DOD can be found, funding of the DP-2 Aircraft concept, in particular in a sole source arrangement, would be imprudent.

TECHNICAL TRIP REPORTS
REVIEW OF THE DP-1 VTOL AIRCRAFT PROJECT – 8-9 MARCH 1999

FROM: John A. Eney, AIR-4.10.6, HEAD, CONCEPT DESIGN DIVISION

1. Attached are (5) individual technical assessments of the duPont DP-1 being built under ONR Contract N47408-98-C-2208. These reports are from selected senior NAVAIR engineers who comprise the DP-1 Oversight Team, as shown in the "team" attachment. These views are based on formal briefings received from the duPont Aerospace Company at La Jolla, CA on 8-9 March 1999, and displays of work in progress at duPont's manufacturing facilities at Gillespie Field, El Cajon, CA.

2. It is noted for the record here that this proposed design was first evaluated by NAWC Warminster in 1986 and concerns were then raised about stability, trimmability and controllability in the hover and transition flight modes. During this present review, the team was shown a working "iron bird" full scale mockup of the flight control and thrust vector control systems, operated by the company test pilot through a computer simulation of the vehicle dynamics. Major questions about the data used in the simulation remain unanswered at this time, after review of written reports received at the meeting. While the pilot demonstrated simulated traffic pattern circuits with vertical takeoff and landing, his mild workload appeared inconsistent with the expected instability and limited control authority inherent in this design.

3. In addition to unanimous concerns about pilot safety, in planned ground tests as well as flight tests, there is serious liability risk in the test site selected at Gillespie Field. The contractor has erected an elevated steel platform above an asphalt parking ramp between rows of occupied hangars and occupied public buildings. The contractor stated that the airport manager had approved this site for tethered strap-down tests of the thrust vectoring system on the basis that the engines being used, P&W 530's, were equivalent to the engines in Cessna Citation aircraft that routinely operate from that airfield. The short-term noise from a departing Citation out on the runway is not comparable to the prolonged full power running of the same (2) engines blasting vertically downward onto asphalt in a builtup public area.

4. Initial assembly of the all-composite monocoque fuselage shell was underway with major components being aligned and mated while resting on wooden sawhorses. There was little attention being given to proper support of flexible shells and panels during critical alignment and marking of major structural joints. The entire aft fuselage conical section is one piece of honeycomb core sandwich layup. The installation of internal structure and control system hardware will require internal jigging for alignment. This airplane is being built from the outside in, rather than the inside out. Proper level jigging of the fuselage for safe support during internal work is necessary.

5 The contractor stated his intent to acquire an ejection seat from an F-14 through sources sounding dubious. It is highly questionable that any ejection seat can be properly fitted to the cockpit of this airplane at this late stage of commitment to design.

6. Further specific issues are raised in the attachments regarding propulsion, structure, materials, controls, and data required to substantiate a Navy flight clearance.

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USAF Combat Rescue Analysis of Alternatives (AoA)

Combat Rescue Future Recovery Vehicle

FINAL REPORT

1 February 2002

DISTRIBUTION STATEMENT E - Distribution authorized to DoD Components only; contains contractor proprietary and commercial information; also contains export controlled technical data due to direct military support; 3 Oct 2001. Other requests for this document shall be referred to HQ ACC/PA

For Official Use Only

Notes:

(1) The various H-60 versions were combined into one modernization alternative. By themselves, none of these platforms will perform the overall mission as well as the existing HH-60G. However, the best qualities of these different platforms can be taken advantage of in an upgrade program.

(2) Several alternatives were maintained for the analysis, but not as primary alternatives. The next section describes the screening and concept groupings.

(3) As with the previous note, these alternatives were kept in the study, but not as the primary alternative. However, these alternatives received more analysis and will have some results shown later in this report.

(4) Procuring an entire new fleet of HH-60Gs was deemed not cost-effective. Procuring new H-60s were analyzed only when needed to increase the size of the fleet.

(5) Industry did not provide response for these alternatives. Without the industry support, there is insufficient data to properly analyze them.

(6) Dropped. These alternatives were considered, but eliminated during the analysis. They were eliminated because they could not realistically meet the IOC (by many years) or were worse than the baseline in key MNS deficiencies. Some of these alternatives received more detailed analysis and will have results shown later in this report

(7) Not feasible. In addition to the dropped alternatives, some alternatives or concepts were never considered because of serious faults. Also, some contractor responses were also deemed infeasible because they were only sub-systems and not complete proposals.

3.2. Screening/Concepts. Once the responses from industry to the request for information (RFI) were received, a screening process was performed. The goal of that process was to remove infeasible/partial systems, recommend alternatives to be deleted from the analysis, perform an initial review of the alternatives, and determine conceptual categories of alternatives.

3.2.1. Infeasible Systems. A new developmental program was deemed infeasible from the beginning because new developments usually take about 20 years causing the IOC to completely miss the requirement (2007-2010). In addition, several corporations submitted responses to the RFI that were deemed infeasible due to incompleteness. That is, these were partial systems or sub-systems instead of a total recovery vehicle response.

3.2.2. Dropped Systems. To the infeasible list, the AoA Study Team added alternatives deemed unacceptable. These alternatives were presented to the AoA Senior Advisory Council (SAC) for their approval to remove them from the study. The alternatives deleted are as follows:

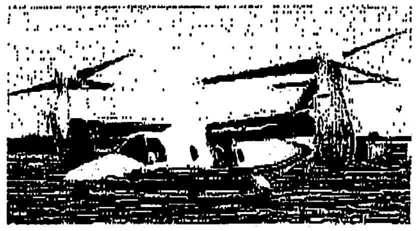
- Bell-Agusta HV-609R. This is a light-lift tilt-rotor currently in final development stages. The primary fault was a lack of space. It has less room than the baseline HH-60G – a MNS deficiency. In addition, the aircraft is a civilian design. Once militarization is performed (armoring, armament, defensive systems, etc), there would be even less space and insufficient power to properly operate the aircraft. This aircraft has potential to cover stateside, peacetime, and training rescue missions. For a combat recovery vehicle it is unacceptable.
- duPont DP-2. This is a thrust-vectored aircraft in early concept and technology development phase. The primary issue was the IOC date. Like the new developmental systems discussed above, this aircraft would take until 2018-2020 to reasonably be fielded in a military, CSAR version. Initial flight-testing on a half-scale version will begin in mid 2002. From there, development and building of the full-scale must take place, flight-testing, militarization, and other major steps are required. This is a new design and new technology, causing a long development time (with potential snags such as the Harrier or Osprey programs). Other

issues include potentially unacceptable environment around/under the recovery vehicle when in a hover mode and high cost. Due to the very high speed of this alternative (over 400 knots), the Air Force should continue to monitor progress in case a major slip to the HH-60G replacement program occurs, or for a vehicle-after-next program. The importance of self deployment and mission reaction time initially gave the DP-2 a favorable rating, however a review for engineering realism relegated the design concept to unproven advanced technology status and resulted in the removal.

- Russian MI-17. This is a medium-lift helicopter in use by several of the former USSR states and their allies. The contractor, MIL, did not respond to the RFI. Therefore, the Study Team did not have the necessary combat rescue configuration and subsystem-related data required to complete an analysis of this alternative.
- US Army/Boeing MH-47E. This is a heavy-lift helicopter in use by the US Army. The contractor, Boeing, did not respond providing no data with which the Study Team could work. Further, the very large size is beyond the needs of this mission area. Informally, the contractor told the Study Team that its size and drawdown of production were primary reasons they did not respond.
- Bell UH-1Y. This is a medium to small helicopter used by US forces for decades. The "Y" version is a 4-bladed variant being purchased by the US Marines. The contractor, Bell, did not respond providing no data with which the Study Team could work. Further, the contractor felt that it was too small and potentially underpowered for this mission area.
- AFSOC MH-53/HH-60 Split Baseline. This concept was to add AFSOC MH-53J/Ms to the HH-60Gs, providing a split fleet. This alternative was originally added by the AFROC because it was an interim option being considered at the time. Since then, the interim option to keep the MH-53J/Ms was rejected by the Air Force Chief of Staff. This lack of senior leadership support, combined with only a small increase in capability (size) and high cost of operating justified removing this alternative. Further this option does not resolve speed, range, survivability, and battle space awareness deficiencies. Note: this alternative is not the same as the "Mixed Fleet" alternative. Both involve using two different aircraft; however, this alternative was a specific mixture of fielded aircraft.
- Piasecki HH-60 VTDP. This alternative will modernize and SLEP the HH-60G aircraft, and add a Vectored Thrust Ducted Propeller (VTDP) system. A large amount of analysis was done on this alternative before discarding due to IOC. Uncertainty of technology, manufacturing, acquisition, IOC, and other risks were identified and validated by the program office. The AoA Study Team recommended deletion from final results since the risks and IOC would cloud the results.

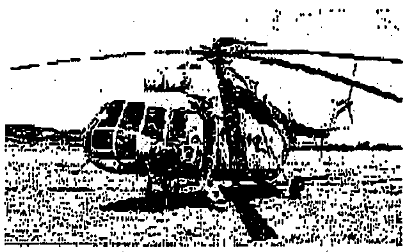
3.2.3. Screening Analysis. After receiving the industry responses to the RFI, the AoA Study Team performed an initial analysis of the alternatives.

- This month-long process involved operators, testers, analysts, engineers, acquisition experts, and logisticians. Their analysis was folded together using a value-model, somewhat similar to the modernization investment process used by ACC. In the model, users arrange the issues in a hierarchical form and place relative weights on each based on its importance. Each issue is scored and placed in the model.
- After performing the computations, the team examined the results looking for omissions, errors, and other factors for a decision. It was out of this process that some of the systems were recommended for deletion.
- There were some systems that appeared would perform better than others, but the team



3.3.5.1. Bell-Agusta BA-609/HV-609. This is a 12,500 lb class tilt-rotor aircraft. The BA-609 is designed for commercial applications while the HV-609 is designed for US Coast Guard use in civil search and rescue. The Bell-Agusta 609 is a six to nine passenger, pressurized cabin, transport aircraft designed for cruise speeds up to 275 knots, at ranges up to 750nm. Operational features include single engine capability, all weather capability (incl. icing), and an aircraft monitoring system. It will not solve the MNS deficiency for cabin space, however.

3.3.5.2. duPont DP-2. This is a new concept from duPont Aerospace, which uses two fan-jet, engines with vectored-thrust. The DP-2 is designed to exceed 1,500nm range at sea level to insert or extract a small number of troops, their equipment, and vehicle(s). The DP-2 is designed to perform VTOL, hover, or a STOL at the delivery or extraction point, and return to base at sea level. As an operations support aircraft, the DP-2 is designed to deliver cargo, equivalent to the combat load, 5,000nm. And as a medical evacuation aircraft, the DP-2 is designed to pick up the wounded in the battle area and fly them directly to rear-area hospitals where specialized medical facilities are available. duPont has combined turbofan engines with composite materials to provide a thrust vectoring propulsion system for VTOL and hover capability and high-speed cruise performance.



3.3.5.3. Russian MI-17. The Mi-17KF Helicopter is a derivative of the Mi-8/Mi-17 mid-size multi-role utility helicopter. The Mi-17 series of helicopter is currently under-going commercial certification with the Russian Civil Aviation Authority. In parallel to the Russian certification effort the helicopter is currently being evaluated to show compliance with the latest version of FAA regulation FAR 29 and with the new avionics will meet the requirements for helicopter IFR certification. The Mi-17 series offers a Cargo Transport, 28 Seat Passenger, to Flying Hospital configuration complete with operating theatre. An auxiliary power unit is fitted as standard to all models for engine start and ground power. The Mi-17 is available with options for flotation system, external cargo sling with 11,000lbs capacity, external winch at entry door with 650lbs capacity, auxiliary fuel tanks to increase range up to 775 statute miles, night vision goggle compatible cockpit, Canadian Marconi Doppler Navigation System, and a Global Positioning System.

3.3.5.4. US Army/Boeing MH-47E. This is a variant of the CH-47 used for US Army special operations and troop movement. The MH-47E has a 5.5-hour endurance over a 300nm radius, at low level, day or night, in adverse weather, over any type of terrain. The MH-47E's integrated avionics system (IAS) permits global communications and navigation. The IAS includes forward-looking infrared (FLIR) and multi-mode radar for nap-of-the-earth and low-level flight operations in conditions of poor visibility and adverse weather. The MH-47E and MH-60K avionics systems are interchangeable.

Table 3-6. Medium-Lift Helicopters, part 2

Alternative #			
Alternative	**Mi-17**	**AS532A2**	**NH-90 TTH**
Manufacturer	MIL	Eurocopter	Eurocopter
Users	Russia	NATO	NATO
Engine(s)/ Intermediate shp ea.	(2) TV3-117V/ 1,950	(2) Maklia 1A2/ 1,657	RTM 322-01/ 3,500
Aircraft Length (ft)	84.3	63.9	52.8
Rotor Diameter (ft)	70.7	53.1	53.4
Aircraft Height (ft)	15.7	16.3	13.8
Weight Empty (lb)	16,000	11,023	14,741
Max T/O Weight (lb)	28,750	24,691	20,062
Max Payload (lb)	8,840	10,593	4,409
Max Cruise Speed (kts)	132	147	161
Range (nm)	260	500	475
Cabin Space (cu ft)			
Disk Loading (lb/sq ft)	7.3	11.15	8.96
Development	Complete	Current	Current
Production	Current	Current	2003

Table 3-7. Compounds, Tilt-Rotors, and Thrust-Vectored Aircraft

Alternative #		4		
Alternative	**HH-60G VTDP**	**CV-22**	**BA-609**	**DP-2**
Manufacturer	Piasecki	Bell-Boeing	Bell-Agusta	duPont
Users	Development	AFSOC	Civil	Development
Engine(s)/ Intermediate shp ea.	(2) T700-701C/1,940 (1) T703 / 500	(2) T406-AD-400 5,890	(2) PT6C-67A 1,850	(2) Turbofans 25,000lb thrust ea.
Aircraft Length (ft)	62.6	57.3	44.0	73.7
Rotor Diameter (ft)	53.7	(2) 38.0	(2) 26.0	55.9 (wingspan)
Aircraft Height (ft)	12.3	22.1 (nacelles vertical)	15.0	25.2
Weight Empty (lb)	12,330	33,140	10,500	26,162
Max T/O Weight (lb)	22,000	52,870/60,000	16,000	64,162
Max Payload (lb)	3,900	20,000	5,500	10,500/30,000
Max Cruise Speed (kts)	205	316	275	0.92 M
Range (nm)	1,883	700/2,100	750	5,000
Cabin Space (cu ft)	344	729	258	1850
Disk Loading (lb/sq ft)	9.5	21.75	15	1136
Development	Start 2004	Current	Current	Current
Production	Start 2012	Current	2002	2007

NASA Analysis of the DP-2 Concept
April 2003

Background
Dupont Company is attempting to develop a family of long range Vertical Takeoff and Landing (VTOL) aircraft. The aircraft would have a 50 passenger capacity, capable of Mach .90 cruise with a range of 5000 nautical miles for short takeoff and landing (STOL) and a range of 1000 nautical miles for VTOL operation, for civil and military applications. Dupont is intending to flight test a six-passenger size demonstrator, known as DP-2. The combination of these mission requirements, while ideal from a market share perspective, requires the aircraft concept to absorb the many problems that resulted from this tremendous mission capability.

Vehicle Sizing Study
The overall question of the value and potential success is a function of the mission problem statement that determines the aircraft design attributes. NASA performed a vehicle sizing study to determine the answer by incrementally investigating the vehicle problems that result from each added capability. As a result of this study, we have concluded that a mission which requires a long-range capability is likely <u>not compatible</u> with Vertical Takeoff and Landing (VTOL) requirements.

Concept Feasibility: Safety and Noise Difficulties
Additionally, the feasibility of the concept is questionable. There are significant challenges that would result in poorer performance than assumed in the ideal case of the vehicle sizing study. The two largest problems are safety of flight and noise. The accepted standard for safety of flight requires that a VTOL vehicle must be capable of transitioning from "forward flight to hover" even if one engine fails. It is NASA's assessment that the thrust to weight of the engine should be much greater than the Dupont design requirement in order to insure a safe landing should an engine failure occur.

The high exhaust velocities associated with direct thrust of VTOL aircraft would exacerbate the noise problem. NASA's analysis indicates that the Dupont design will generate much greater noise than a conventional turbofan transport. Since the Dupont concept would operate at least as close, if not closer, to the public as conventional transports, the noise constraint is critical for this concept to have any value.

Conclusion
NASA's study concludes that the DP-2 demonstrator is not appropriately matched to the specified requirements. Fabrication and testing of this demonstrator appears premature because insufficient analysis has been performed to merit large-scale testing. Dupont has not performed a comparison of their design with alternate design studies of similar requirements and, as a result, a non-optimal demonstration plan will result as design problems are discovered after the fact, requiring additional effort and significant funding for redesign.

As a result of careful evaluation, it is NASA's assessment that the DP-2 effort is not worthy of continued funding.

3/21/03

Review of duPont Aerospace Progress Reports and Clean Sheet Analysis

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A review of progress report 2 and 3, along with the "Clean Sheet of Paper Systems Analysis of Commercial DP-2" was conducted by the Langley Systems Analysis Branch. The intent of this review was to determine if these updates changed the prior analysis results and reviews that were conducted by this branch. This response memo concentrates on a review of the systems analysis effort conducted by du Pont. There was insufficient time for a peer review or detailed comments, however, subsequent versions of this memo will include these items if requested.

The 2nd and 3rd progress report concentrate on the propulsion flowpath analysis, fabrication, and testing efforts being conducted jointly by NASA Glenn and duPont Aerospace. From these reports it appears that progress is being made in the integration of the P&W engines, along with improvements and modifications to the intake, diffuser, cascades, and control box. The hover testing led to failure of a cascade element at initial wheels-off high thrust run-up, with new cascades vanes being fabricated with unidirectional plys added in the spanwise direction. Our initial assessment is that this fix is probably not optimal to address the cascade structure problem[1]. Appearances are from the progress reports that significant time, effort and cost are going towards modifications of the current demonstrator to permit the new engines and modified flowpath and cascades to be integrated. Design changes such as these can be expected in any demonstration program, however, significant resources could have been saved if these types of analysis had been performed prior to fabricating a demonstrator.

The results of the du Pont clean sheet analysis are not in agreement with past STOL commercial transports studies, and the conclusions of this study do not appear to be well founded. The purpose of the study was to show required thrust to weight (T/W) and wing loadings for transports with a 3000 ft field length requirement. An initial concept of operations for Runway Independent Aircraft is also included with this memo to assist in understanding the requirements for this class of vehicle. Some of the assumptions for the study are inappropriate, namely a severe limit on the Clmax, that causes the results to be particularly skewed to high T/W systems. The du Pont conclusions are that the least weight penalty occurs for vehicles with T/W on the order of 1.35, and that a VTOL requirement is the minimum weight penalty solution. Two recent regional STOL transports studies conducted by Boeing and Swales have been included with this memo that demonstrate a 2000 to 4000 ft field length can be achieved at relatively modest T/W ratios, that result in concepts that would be far more economical and practical. Optimization for minimum total operating cost and a 3000' field length will result in a required T/W of approximately .5 to .7 depending on the method of producing high-lift; this result is less than half of the du Pont result. This difference in T/W has major effects on the vehicle viability, including acquisition cost, noise, operating cost, and fuel burn emissions that are not competitive to alternate approaches. The results of the du Pont study indicate that a key technology investment should occur to move the minimum thrust specific fuel consumption point to approximately 40% thrust, instead of the current 80% to accommodate the large turn-down ratio of their high T/W solution. While this is an important technology for VTOL concepts, it is of less significance for STOL concepts, and many other technologies are more critical for economically and environmentally viable concepts, including aerodynamic, propulsion, aero-acoustic and control technologies. One technology in particular that appears to be of great interest specifically to this STOL transport mission, is research of over-wing nacelle concepts that provide the ability to integrate ultra-high bypass ratio engines for low noise, upper surface blowing for high-lift, and high-speed subsonic cruise drag reductions. A paper has been attached to this memo that shows higher-order analysis of this concept, particular to potential drag reductions.

There continues to be a significant difference of opinion relating to the VTOL engine-out certification. Only a one-page explanation was included in the du Pont papers, with very limited information. The du Pont conclusion is that single engine failure in hover sizes the propulsion system for a two engine VTOL with a T/W of approximately 1.3. A detailed transition analysis is required to determine the sizing condition, but it will be during approach, and not at the hover condition. It is suggested that du Pont supply a time step analysis showing wing borne and propulsion lift during deceleration with the velocity and distance along the deceleration path to clarify this issue. During the deceleration, the vehicle must be able to maintain a total lift of one times the weight if it is maintaining altitude. At some point during deceleration as the vehicle transitions from wing lift to propulsion lift there will be a propulsion lift deficit unless the T/W is greater than 1.0 with one engine failed (accounting for all forces acting on the body and all thrust losses on the system). The du Pont sizing condition will be at a high-hot day with turning and suckdown losses, and engine overspool to maximize thrust, and the T/W (or more appropriately Lift/Weight) with one engine inoperative will be approximately .7 at these conditions. At some speed which is less than the stall speed, there will be insufficient thrust to either accelerate and fly-around, or land with a controlled rate of descent.

The conclusion from review of the du Pont system study is that this is not an accurate or fair assessment of an optimal STOL 3000 ft field length vehicle. The assumptions bias the results to artificially high T/W ratios, and the du Pont concept would clearly not be able to economically compete with alternate designs of reduced T/W ratios. There remains a significant difference in opinion of the required T/W for VTOL operation, and a conclusive answer requires a transition analysis, with enough data to determine that sufficient lift and thrust exist for a controlled descent. The conclusion remains that this demonstrator is ill matched to the specified requirements, and comparison to alternate design studies of similar requirements is suggested. Fabrication and testing of this demonstrator appears premature, because insufficient analysis has been performed to merit large-scale testing. This is, and will result in a non-optimal demonstration plan, as design problems are discovered after the fact, requiring additional effort and cost for redesign.

Notes

[1]This observation is based on the visual inspection of the photos attached to the du Pont progress reports, and not upon detailed analysis, therefore this information is presented for discussion and assistance, not as a conclusive opinion. The addition of unidirectional plys in the spanwise direction will result in a thicker skin, and therefore increased stiffness. However, the structural failure of the cascade blade appeared at the max bending moment loading (at the center between supports) and from Figure 3 appears to have propagated from the trailing edge. Upon close inspection of Figure 15 the trailing edge appears not to have plys wrapping from the upper to the lower surface. In addition only a single upper to lower surface spar support exists at the center of the chord, with a large percentage of unsupported chord. There appear to be two failure modes that are applicable to this cascade structural layout. If the failure was induced through trailing edge peeling or de-lamination, this could easily be solved by wrapping plys around the trailing edge to provide a tensile strength to prevent peel-away between the upper and lower surface. If the failure was induced by column buckling across the chord, this could be easily resolved by incorporating additional spar elements.